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Elisha Mitchell Scientific Society

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ISSUED QUARTERLY

CHAPEL HILL, N. C., U. S. A.

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PLATE 1

HYDNELLUM CAROLINIANUM No. 1243 (*Above*)
HYDNELLUM ZONATUM. No. 1238 (*Below*)

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INDUSTRIAL APPLICATIONS OF ZIRCONIUM AND ITS COMPOUNDS

By F. P. Venable

PRECIOUS STONES

The earliest use made of a compound of zirconium was that of the natural silicate as a precious stone. It was known under the names zircon, jargon, and hyacinth, and in early times was also supposed to have medicinal value. The use of the name hyacinth among the ancients was confusing as, besides the zircon, it sometimes meant the carbuncle and also a dark amethyst. The zircon, known by lapidaries commonly as the Ceylon zircon or jargon, was regarded as distinct from the hyacinth and was usually colored fire-red, yellow, yellowish-green or gray. The hyacinth was distinguished as oriental hyacinth. Its color was deep red with a touch of brown or sometimes of orange red. Zircons show a great variety of colors from colorless to red, brown, yellow, green, gray, white, pink, and blue, besides intermediate tints. They may be translucent, but ordinarily are opaque.

On account of its hardness (7.5) the zircon is cut with diamond powder or emery. It is cut in the rose, table, or brilliant form. The value depends chiefly upon the purity of the color. On account of its lustre and hardness it has been substituted for the diamond. Indeed, at one time it was supposed to be an inferior variety of diamond. It has been used in jeweling watches and as supports for the knife edges

of fine balances. There is little demand for it at present in jewelry except in the case of fine crystals of pure color. At one time it was supposed to be peculiarly appropriate and was much used in mourning jewelry. Artificial zircons have been more or less successfully produced.

OXY-HYDROGEN LIGHT

The brilliancy of the light given off by zirconia in the oxy-hydrogen flame was first observed by Hare in 1820 in his effort to fuse it. After the development of the Drummond or lime light it was suggested that zirconia be used as a substitute for the lime, offering the advantages of slight absorbing power for carbon dioxide or water. In 1868 du Motay used it in one of the lamps lighting the Tuileries. Napoleon III was so pleased with the result that he ordered its installation in all of the lamps illuminating the court and gardens. The zirconia light attracted much attention on the part of inventors and others. On account of the purity of the light and the high emissive power of the zirconia it was recommended for scientific use, as in polariscopes, spectroscopes, etc., but this more especially refers to the next form.

GAS MANTLES

With the introduction of the Welsbach mantles interest in the Drummond light diminished. The first incandescent mantles made by Welsbach in 1880 consisted essentially of zirconia. Later this was largely substituted by the oxides of thorium and cerium which have a higher emissive power. Zirconia is used in admixture with these and other rare earths.

INCANDESCENT LIGHT

A number of attempts have been made to use metallic zirconium in the form of filaments in incandescent electric lamps. Its electrical conductivity and high fusing point should render it quite suitable for this purpose. Korolkow has made an examination of the electrical resistance, emissive power, and expansion coefficient of zirconium filaments, but such determinations are considerably affected by the presence of even small amounts of impurities. One difficulty which has to be met is the preparation of pure zirconium on a commercial scale and at a reasonable cost. Most of the experiments with zirconium filaments have been carried out with the more or less impure metal, sometimes associated with the carbide which itself has been said to be unsuitable

for the purpose. The properties of zirconium seem to favor its use as a substitute for tungsten should the difficulties in the way of its commercial production be overcome, and its abundance and wide distribution would speedily make it replace the more costly metal. A number of patents have been taken out bearing on the manufacture of the filaments. The use of zirconium hydroxide has been patented for the lining of shells, presumably as containers for gas-forming liquids or solids which might be affected by contact with steel. According to Meyer, investigators who have succeeded in producing malleable zirconium state that it has remarkable properties which fit it for use in the chemical laboratory as a substitute for platinum. So far nothing has been published on this subject.

EXTRACTION OF GOLD

A patent has been granted for the use of ores containing zirconium in extracting gold, platinum, and other noble metals from their ores. The supposition is that zirconium in the metallic state is the active agent.

REDUCTION OF METALS

There is another patent for the use of zirconium, its alloys with magnesium or aluminum, its carbide or phosphide as a means of reducing other metals or forming alloys with them. The reaction is said to be exothermic, and hence proceeds from its own heat after starting.

ALLOYS

Various alloys of zirconium have been formed. The ferro and nickel alloys promise the greater usefulness. Bronzes have also been made. Cobalt, aluminum and magnesium alloys have been placed on the market. Ferro-zirconium has been recommended in steel manufacture for removing oxygen and nitrogen. It has been offered commercially, containing 40 to 90 per cent of zirconium. Small percentages of titanium have also been introduced.

It is claimed that these alloys are not subject to oxidation and are very resistant to chemical reagents. The alloys have a metallic lustre, and some of them take a silvery steel-like polish. They are readily malleable and may find a use as filaments for incandescent lamps. Such filaments are claimed to have the power of selective radiations; in other words, emit more light than corresponds to the temperature at which they are heated by the electric current. This implies a con-

siderably lower wattage per candle-power than is now required by the average metal filament lamp. Analysis of one such alloy shows zirconium, 65 per cent; iron, 26 per cent; titanium, 0.12 per cent; and aluminum, 7.7 per cent. These alloys are produced by reduction with finely divided aluminum together with the mixed oxides of iron, titanium, or whatever metal it is desired to introduce with the alloy. Or they may be produced by heating the mixed oxides in a graphite crucible in an electric furnace using either zircon or zirkelite as a source of zirconium.

For use as a scavenger in casting steel a 20 per cent ferro-zirconium is recommended in an amount equal to 1 per cent of the weight of steel treated.

FURNACE ELECTRODES

Mixed with good conductors zirconia is said to improve furnace electrodes. On account of its low conductivity for both heat and electricity it can also serve as an insulating material. It is further used to replace thorium nitrate for coating the iridium bar and preventing the loss of iridium in the Heraeus furnace.

The oxide, zirconia, possesses physical and chemical properties which make it available for a variety of industrial uses. Among these properties are its high melting point and its low heat conductivity. On account of its low coefficient of expansion it withstands sudden changes of temperature. Its porosity is low so that it is practically impervious to liquids. It is inactive toward most chemicals and scarcely attacked by strong acids or alkaline fusion mixtures. It does not, however, resist the action of hydrofluoric acid and fluorides. Fused bisulphates also act upon it to some extent. It is therefore quite stable in the presence of most fluxes and slags.

As binding material various organic substances, as starch, organic acids, glycerin, tar, etc., have been recommended; also magnesia, phosphates, and borates. Since the native zirconia from Brazil is reasonably pure, it may be used direct with no other than mechanical treatment. Native zirconia begins to fuse at 1,800° C. For use in laboratories and chemical manufacture it is first purified. The chief impurities to be removed are iron, titanium, and silicon.

Working tests show that it has much greater life duration as a lining for furnaces than other refractories. In Germany, experiments were carried out in a closed-hearth steel furnace, and it was found that the zirconia lining was good for eight months use without renewal. This is several times longer than the usual life. Because of the low thermal conductivity the thickness of the lining could be reduced one-half, a two-inch lining being equal to four inches of chamotte. Furthermore, there was a saving of one-half in maintenance costs. In casting molds it shows a high resistance to steel, copper, brass, and bronzes.

It may be used as a protective coating for ordinary fire brick exposed to the action of acids or slags. In such cases sodium silicate serves as a binding material, also air-slaked lime may be added. If it is desirable to increase the porosity and decrease the density, organic substances or volatile salts may be added and burned out in the firing. It is, of course, detrimental to use a binder which may cause softening at comparatively low temperatures.

As a refractory it has also been used in making crucibles, muffles, pyrometer tubes, and for a variety of chemical ware. Combustion tubes made of it are said to be gas-tight up to 1,000° C. Crucibles and combustion tubes of zirconia have been used in the research laboratory of the Royal Berlin Porcelain factory, as they possess great strength and also conduct electricity. They withstand high temperatures and sudden changes. Zirconia crucibles have been used for determining the melting points of pure iron, tungsten alloys, and platinum. Such ware can be plunged in water while red hot without injury.

ENAMELS

Zirconia is also used as an opacifying agent in enamels and a clouding agent in glass as a substitute for the costly stannic oxide and the poisonous compounds of antimony and arsenic. For this purpose it should be quite free from iron, and a number of processes have been worked out and patented. The increasing demand for tin for other purposes and the limited supply may render this substitution necessary. According to some authorities the zirconia has less covering power than stannic oxide. For cheaper ware native zirconia may be used, or ground zircon which

has been treated with hydrochloric acid, then caustic soda, and lastly leached with acidulated water. This would only partially remove the iron present.

GLASS The use of zirconia as a clouding agent for glass has been mentioned above. A thorough comparison with stannic oxide in this application apparently has not been worked out.

The addition of a small amount of zirconia to vitreosil or silica glass is said to increase the tensile strength and resistance to bending or breaking, and to diminish the tendency to devitrification. The temperature at which the ware softens is practically unchanged. The appearance is not improved.

TEXTILE INDUSTRY Zirconium salts, as the hydrated sulphate or the acetate, have been used as a weighting filler for silk. The weight may be increased up to 50 per cent. Stannic salts are ordinarily employed for this purpose.

Various zirconium compounds are also used as mordants in dyeing and in the preparation of lac dyes. Zircon white is used as a pigment, having good covering powers and being unaffected by chemical agents. A patent has also been issued for the preparation of a zirconyl tannate.

COLLOIDAL HYDROXIDE The colloidal properties of the hydroxide have been compared with those of other hydroxides and its use suggested in the purification of water. Also it may find a use as a substitute for sodium tungstate or stannate in rendering cloth non-inflammable.

MEDICINAL As "Kontrastin" it may be substituted for bismuthyl nitrate as a lining substance for the stomach, etc., in X-ray observations and radiographs. It has the advantage of being non-poisonous.

ABRASIVE The carbide has been recommended as a polishing agent, abrasive, and for glass cutting.

CHLORINATING AGENT Willgerodt has suggested the use of the tetrachloride as a chlorinating agent.

CHAPEL HILL, N. C.

THE HYDNUMS OF NORTH CAROLINA

BY W. C. COKER

Fungi with the hymenium borne on distinct spine-like teeth which are typically terete and pointed, and hang vertically. Plant body upright with a distinct stem and cap, or laterally sessile, or the teeth attached to a resupinate stratum; texture varying from fleshy and brittle to tough and pliable. Spores white to brown, smooth or tuberculate or papillate or echinulate. Growing on earth, leaf mold, decaying wood, or injured living trees. Many are edible and none are known to be poisonous. With one exception, the plants here treated include only such as belong to the genera Hydnum and Phaeodon in the sense of Hennings (Engler and Prantl's Pflanzenfamilien. Leipzich. 1900). The family Hydnaceae is now broken up into a large number of genera, including many inconspicuous resupinate plants. In some the teeth are mere knobs or papillæ in others they are more or less flattened or fused and vary towards the Polyporaceae. With the exception of Hydnochaete, all such are here omitted. For special studies of the genera here treated as well as of other smaller and less conspicuous genera of the family, see the following papers by Dr. H. J. Banker:*

A Preliminary Contribution to a Knowledge of the Hydnaceae. Bull. Torr. B. C. **28**:199. 1901.

A Contribution to a Revision of the North American Hydnaceae. Memoirs Torr. B. C. **12**: No. 2. 1906.

Type Studies of the Hydnaceae:

I. *The Genus Manina.* Mycologia **4**:271. 1912.

II. *The Genus Steccherinum.* Mycologia **4**:309. 1912.

III. *The Genus Sarcodon.* Mycologia **5**:12. 1913.

IV. *The Genus Phellodon.* Mycologia **5**:62. 1913.

V. *The Genus Hydnellum.* Mycologia **5**:194. 1913.

VI. *The Genera Creolophus, Echinodontium, Gloiodon, Hydnodon.* Mycologia **5**:293. 1913.

VII. *The Genera Asterodon and Hydnochaete.* Mycologia **6**:231. 1914.

Also see *The Genus Radulum,* by C. G. Lloyd. Cincinnati. May, 1917.

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*Dr. Banker has with great kindness and patience looked over a considerable number of my collections, and I take pleasure in acknowledging his very helpful advice. As I have not always followed his opinion, he must not be thought responsible for any of the errors.

The two plates in color are from paintings by my niece, Gladys Coker; the photographs are all by me except that of *Phellodon alboniger* which is by Beardslee. All are natural size unless otherwise indicated. The spore drawings are all by me, with a magnification of 2160. They have been inked in by several members of the laboratory staff.

KEY TO THE GENERA

Plants with a distinct cap and more or less central stem; texture fleshy, brittle; growing on the ground ..... *Hydnum* (p. 166)
Plants without a distinct cap and stem; soft, fleshy; growing on wood; tuberculate or intricately branched ..... *Manina* (p. 176)
Plants with a distinct cap which is laterally sessile or stalked; texture tough, fibrous and dry; growing on wood ..... *Steccherinum* (p. 178)
Plants with a stalk and cap; texture spongy or tough (often spongy above and hard below); growing on the ground.
  Spores warted and angular..... *Hydnellum* (p. 181)
  Spores echinulate or papillate..... *Phellodon* (p. 192)
Plants entirely resupinate, the teeth simple or branched, usually flattened; color rusty-cinnamon; texture firm and tough..... *Hydnochaete* (p. 197)
Plant toughish-gelatinous, watery, translucent, broadened and bent over at the top, the very small teeth hanging from the under side..... *Tremellodon**

In addition to the keys for species under each genus we give below a general key for all the species that are here treated:

KEY TO ALL THE SPECIES HERE STUDIED†

Growing on wood.
  Without a distinct cap, plants large, laterally attached.
    Solid and nearly simple, covered nearly all over with large spines..... *Manina cordiformis* (1)
    Repeatedly and delicately branched, covered all over with short spines..... *Manina flagellum* (2)
  With a distinct cap which is attached at the side and strongly tomentose; no stem.
    Color light grayish-brown; flesh dry, fibrous... *Steccherinum Rhois* (2)
    Color light-buff or rosy-buff at maturity; flesh juicy ..... *Steccherinum pulcherrimum* (1)
  With a distinct cap, usually with a stem; smooth or very minutely tomentose ..... *Steccherinum adustum* (3)
Growing on the ground.
  Having a distinct, strong odor, at least in drying, which is usually of fenugreek, or slippery elm bark, or a more fetid pig-pen odor.
    Very small, up to 1.5 cm. broad..... *Phellodon Ellisianus* (5)
    Over 1.5 cm. broad.
      Taste peppery or sour, odor of fenugreek.
        Taste peppery ..... *Hydnellum diabolus* (1)
        Taste sour ..... *Phellodon Cokeri* (4)
      Not peppery or sour, spores white, odor fetid. *Phellodon amicus* (1)

*This is not one of the *Hydnaceae*, but is keyed here because of its pendant, awl-like teeth. It will be found under the *Tremellaceae*.
†The numbers refer to the species number under the genus indicated.

No strong odor of fenugreek, etc., and not fetid.
Color a deep orange salmon on younger parts...*Hydnellum floriforme* (5)

Color not orange salmon.
Texture homogeneous, fleshy and soft throughout, size medium to large.
Cap scaly; stem tapering to a small root.
Base of stem white.....*Hydnum Underwoodii* (6), *and Hydnum Murrillii* (8)
Base of stem greenish.....*Hydnum fuligineo-violaceum* (7)
Cap scaly; stem not as above.....*Hydnum imbricatum* (3)
Cap densely tomentose or strigose.....*Hydnum cristatum* (4)
Cap smooth, pale flesh color.....*Hydnum scabripes* (5)
Cap smooth, buff color.....*Hydnum repandum* (1)
Cap smooth, white.....*Hydnum albomagnum* (2)
Cap smooth, pale rose.....*Hydnum roseolus* (9)
Cap smooth, smoky olive when dry.....*Hydnum fumosus* (10)

Texture nearly homogeneous, tough, fibrous, flexible when fresh; plants small, cinnamon or chestnut brown when dry.
Margin pink or white when growing; distinctly zonate.
Margin usually pinkish when fresh, spores brown, roughly tuberculate..*Hydnellum zonatum* (4)
Margin whitish when fresh, spores white, echinulate .....*Phellodon tomentosus* (3)
Margin not pink or white, scarcely zonate, center with rough asperities, surface felted-tomentose .....*Hydnellum scrobiculatum* (3)
Texture homogeneous, half-fleshy, toughish; plants rather large, color not as above....*Hydnellum humidum* (7)
Texture distinctly duplex, a soft, spongy outer layer and a firm, tough inner layer.
Hard core of stem and cap black; spores white .....*Phellodon alboniger* (2)
Hard core of stem and cap not black; spores brown.
Cap cinnamon brown or umber.
Cap convex or plane.....*Hydnellum velutinum* (2)
Cap depressed to infundibuliform.*Hydnellum Nuttallii**
Cap buff or tan.
Plant heavy and compact.....*Hydnellum ferrugipes* (6)
Plant light and slender.....*Hydnellum carolinianum* (7)

*See foot-note, page 183.

GENUS HYDNUM

Plants with a cap and stem; fleshy; smooth, or scaly; growing on the ground. This includes also the genus Sarcodon, as treated by Banker.

KEY TO THE SPECIES.

Cap scaly, stem tapering to a small root.
- Base of stem white.....*H. Underwoodii.* (6) *and H. Murrillii* (8)
- Base of stem greenish.....*H. fuligineo-violaceum* (7)

Cap scaly; stem not as above.....*H. imbricatum* (3)
Cap densely tomentose or strigose.....*H. cristatum* (4)
Cap smooth, pale flesh color.....*H. scabripes* (5)
Cap smooth, buff color.....*H. repandum* (1)
Cap smooth, white.....*H. albo-magnum* (2)
Cap smooth, pale rose.....*H. roseolus* (9)
Cap smooth, smoky olive when dry.....*H. fumosus* (10)

1. **Hydnum repandum** L.

PLATES 2 AND 27.

Cap up to 10.5 cm. in diameter, usually convex, uneven and irregular, the margin wavy and often indented nearly to the stem; surface smooth, with the appearance and feel of leather; color a distinct and rather uniform buff, never white. Flesh soft, white, usually brittle, rather thick; odor and taste slight.

Spines soft and fragile, cream color when fresh, turning dark reddish brown in drying, slightly decurrent.

Stem smooth, solid, up to 7.5 cm. long, but generally from 4-6.5 cm. long and about 1.3 cm. broad at top, usually enlarged considerably at base; color a light creamy buff.

Spores (of No. 603) white, smooth, subglobose, 6.3-7.4 x 7-8μ.

This is a firm and attractive species and considered excellent for food. It is not uncommon in mixed woods. It may be easily distinguished from *H. albo-magnum,* its nearest relative, by the white color, elliptic spores and pine-woods habitat of the latter. Banker does not regard our plant as exactly typical *H. repandum,* but they do not seem to differ from Bulliard's good figures (Pl. 172). For other good illustrations see Gibson, Our Edible Toadstools and Mushrooms, Pl. 27; and Taylor, Food Products I, frontispiece.

PLATE 2

PLATE 2

HYDNUM REPANDUM. No. 895

PLATE 3

PLATE 3

HYDNUM ALBO-MAGNUM. No. 991

288. Mixed woods, Battle's Park, September 25, 1910. Spores about 7.5μ in diameter.
289. Ravine east of Tenny's, mossy earth, September 24, 1905.
348. Battle's Park, near branch, October 2, 1911.
527. Woods northeast of schoolhouse, October 9, 1912.
603. Near branch back of athletic field, October 21, 1912.
848. Woods by Howell's Branch, September 26, 1913. Photo. Spores spherical, white, 5.5-7.4μ in diameter.
895. Battle's Park, east of Dr. Battle's, October 8, 1913. Photo.
1278. In mixed woods near the branch southeast of athletic field, September 28, 1914.
1452. Woods south of cemetery, October 29, 1914.

Montreat, rich woods, near mountain brook, July 6, 1915. Coker.
Blowing Rock. Atkinson.
Common in woods. Curtis.

2. **Hydnum albo-magnum** Banker

PLATES 3 AND 27.

Cap up to 11 cm. broad, more or less wavy, the center usually depressed and margin lobed, surface smoothish or minutely velvety in places, adhering to trash when young, but this seems due to the surface layer growing around and into the trash rather than to viscidity, as each twig and pine leaf is lying in a little trough and there is no noticeable viscidity at maturity even when soaked; color pure white or creamy in places, not changing color when rubbed. Flesh up to 1.4 cm. thick, abruptly narrowed to the thin margin which scarcely extends beyond the spines. It is pure white, solid, but rather soft and fragile, taste sweetish and quite pleasant, odor faintly aromatic. The upper 2 or 3 mm. of the flesh, which cannot be distinguished from the rest when not soaked, will immediately imbibe a large amount of water and become clear and translucent, in sharp contrast to the nonbibulous opaque white part beneath.

Spines up to 5 mm. long towards center, shortening towards margin, but the long ones also having much shorter ones mixed among them. They are slender, sharp pointed, about 1/3-1/2 mm. thick at base, fragile and easily breaking away from the cap, only slightly decurrent.

Stem short, central or eccentric, expanding above into the cap, pointed below, about 1.5 cm. thick in middle; texture solid and

scarcely firmer than that of the cap, surface white or cream, smoothish, the apex dotted with the fading spines.

Spores ovate-elliptic, smooth, white, 4-4.4 x 6-6.8μ.

This plant is new to North Carolina and has not, in fact, been found before outside the type locality in Alabama. It is a good species, easily distinct from *H. repandum*.

1991. Oak and pine woods south of old schoolhouse, November 21, 1915. Photo.

3. **Hydnum imbricatum** L.

Sarcodon imbricatus (L.) Karst.

PLATES 4 AND 27.

This is our largest terrestrial Hydnum, the cap reaching a width of 22 cm. It grows from the ground on a distinct stem, is single or sometimes cespitose, and may be distinguished by its scaly cap and deep smoky-brown or umber color. Cap expanded from a central or eccentric stem, irregular, strongly imbricate-scaly as a rule, with the margin thin and lobed (usually) and with smaller scales; color a deep brown, often blackish in drying. Flesh soft, but toughish and pliable, pale brownish, thin except in center.

Stem usually short for the size of the plant, about 3-6 cm. long, and 1.5-3.5 cm. thick, rarely up to 9 cm. long; surface irregular, smooth below, marked at top by the descending spines, color like that of cap or lighter.

Spines color of the cap, about 1 cm. long, shortening towards the margin, which they almost reach.

The species is not uncommon in deciduous woods in summer and fall. It reaches a much larger size than allowed by Banker for the plants he describes under *H. imbricatum*, and he is inclined to believe that there are several distinct forms now passing under that name. Lloyd thinks (Myc. Notes **40**:552. 1916) that most, at least, of the records of *H. imbricatum* in America are really for *H. adpressum* or *H. subsquamosum*. But our Chapel Hill plant is just like his figure of *H. imbricatum* (fig. 758) and varies into forms having other names. Figures of the European plant, such as Krombh., Pl. 49, and Schaeff., Pl. 140, could easily be substituted for ours. I feel sure that we have

PLATE 4

HYDNUM IMBRICATUM. No. 413

but one species of this type at Chapel Hill, and I think it best to refer it to *H. imbricatum*. The scales may become very dark on a little exposure. Again they may be represented only by inherent mottlings except in the very center, and such plants (as our No. 1525) could as well be referred to *H. laevigatum*. All gradations are found between. *Hydnum laevigatum* has been listed from North Carolina by Schweinitz, Curtis, and Memminger. As understood in America, the species seems to differ from *H. imbricatum* only in its nearly smooth cap, the center more or less scaly. As all gradations occur between this condition and the typically scaly cap of the latter we do not know how to separate them. *Hydnum subsquamosum* has also been reported from this state by Curtis and by Memminger (MS. notes) but seems equally elusive and uncertain in its characters.*

291. Oak woods, top of Lone Pine Hill, September 14, 1910.
413. Near path from west gate of campus, south of Dr. Battle's, October 31, 1911.
467. Woods on hill south of branch, Battle's Park, September 30, 1912.
525. Woods east of schoolhouse, October 9, 1912. Scales inherent except in very center.
841. Woods east of Tenny's, September 26, 1913.
1182. Mixed dry woods south of athletic field, July 20, 1914.

Arden, September, 1915, sent by Mrs. I. M. Jervey. Size 21.5 x 18 cm. (U. N. C. Herb. No. 2016).

Middle and upper districts, earth in woods. Curtis.

4. **Hydnum cristatum** Bres.

Sarcodon cristatus (Bres.) Banker

This species, the type of which was collected at Blowing Rock by Atkinson, is reported by Banker from several Northern States. We

**Hydnum canum* Schw. was described from this State. Of it Banker says: "The specimen in the Schweinitz herbarium throws little light on this species as it is a mere fragment and suggests a tough coriaceous plant rather than a fleshy one. Fries treated the species as a synonym of *H. grocile* and Schweinitz himself expressed doubt as to the validity of the species." The original description is as follows (Syn. Fung. Car. 77. 1818):

"H. cinereo-albidum, pileo carnoso glabro, subulis et stipite longis. Passim in abruptis muscosis. Magnitudo Hydni subsquamosi, uncialis et triuncialis."

Hydnum Curtisii Berkeley, described from South Carolina, is of doubtful validity. The original description is as follows (Grevillea 1:71. 1872):

"Fuligineo-fuscum; pileo orbiculari laevi; margine inflexo; stipite centrali sursum attenuato; aculeis elongatis acutis integris. No. 2809. Car. Inf.

"Whole plant of a dingy brown; pileus ¾ inch across, even; margin inflexed; stem bulbous at the base, where it is nearly ½ an inch thick, attenuated upwards; spines even, entire, elongated. Allied to *H. laevigatum*."

have not found it and take the following from Banker (Memoirs T. B. C. **12**: No. 2, p. 140. 1906):

"Plants terrestrial, mesopodous, yellowish, 6-10 cm. high; pileus convex to subplane, more or less uneven, irregular, 3-10 cm. wide; margin subrepand, sterile; surface densely velvety tomentose to strigose hairy, in the latter case the hairs forming more or less anastomosing ridges or crests, the hairs usually branching, disc often floccose, color tan or ochre yellow, at margin lighter to whitish; substance fleshy to somewhat tough, pale brown; stem stout, solid, subcylindrical or tapering somewhat to the base, subvelutinus or with spine-like crests of strigose hairs, tawny, 1-5 cm. long by 1-2 cm. wide; teeth slender, terete, even, obtuse, decurrent, tawny olive to fuscous becoming dark brown with whitish tips in drying, '3-6 mm. long,' when dried 2-3 mm. long by 0.1-0.3 mm. wide, 2 or 3 to one millimeter; spores subglobose, tuberculate with small warts, 4-5μ wide, 'tawny olive on paper'; taste acrid. Ground in mixed woods. Aug.-Sept."

5. **Hydnum scabripes** Pk.

Sarcodon scabripes (Pk.) Banker

PLATES 5, 6, AND 27.

Large, irregular, fleshy plants with eccentric stems. Cap up to 14 cm. wide, convex, depressed in center, quite irregular and excentrically expanded, surface smooth, leathery, a pale flesh color. Flesh pallid white, but turning brownish-flesh color when cut, soft, tender and with a mild pleasant taste, about 2 cm. thick at stem, the margin very thin, free and extending about 3 mm. beyond the teeth as in *H. imbricatum,* sharply bent down.

Spines whitish at first then deep snuff brown, except for the ashy-white tips, irregularly decurrent. They are about 8 mm. long near the stem, shorter towards the margin, the tips rather bluntly rounded.

Stem eccentric, heavy, thick, about 4-6 cm. long, and 2.5-3 cm. thick, enlarged and bent at the base and frequently giving rise there to small secondary, aborted plants, surface smooth except where marked by the descending spines which extend down the stem on some sides and not on others, often becoming so short as to be mere dots.

PLATE 5

HYDNUM SCABRIPES. No. 1836

PLATE 6

PLATE 6

HYDNUM SCABRIPES. No. 1836

Flesh solid, firmer and shorter than that of cap, light grayish-brown, turning deeper flesh brown when cut.

Spores a dull brown, about avellaneous of Ridgway, roughly isodiometric, star-shaped and other irregular forms from the large tuberculate warts, 6.3-7.2 x 6.3-8.1μ.

This large and interesting species is new to the South, having been known before only from New York. It is at once distinguished from *H. imbricatum* by the smooth, leathery surface of a pale flesh color, and by the very different spores.

1836. In rather dry soil, pine and oak woods south of Piney Prospect, September 20, 1915. Photo and drawing of spores.

6. **Hydnum Underwoodii** (Banker)
Sarcodon fennicus Karst. ?

PLATES 7 AND 27.

Cap up to 6.5 cm. wide, slightly convex or nearly plane, somewhat depressed in center when mature, rather wavy and irregular, the margin often indented; surface dry, covered all over with rather small low scales or the margin merely floccose or nearly smooth; apparently less scaly in youth; color vinaceous brown, about fawn; margin very thin, free for about 1-2 mm. and bent under. Flesh white, about 4-5 mm. thick near stem, firm, fleshy, elastic, bitter.

Spines nearly white when young, soon a clear brown except for the ashy-white tips. They are quite fine and short, only 1-2 mm. long, sharply pointed, very decurrent, usually almost to the base of the stem, becoming shorter downwards to mere granules below. When dry they are very brittle and easily fall away, and become a uniform brown, about snuff brown to sudan brown.

Stem 3.5-7 cm. long, about 8-10 mm. thick near center, sometimes swollen and fistulose, always quite crooked, usually strongly bent at the ground, expanding into the cap above, tapering downward, and continuing to taper more rapidly in the ground to a sharply pointed root, deep snuff brown, the rooting base abruptly pure white; flesh firm, toughish, elastic, brownish.

Spores (of No. 1837) dusky brown, about avellaneous of Ridgway, roughly spherical with large tubercles giving star and other fantastic shapes; one oil drop, 5.5-6.5 x 6.3-7.8μ.

A very distinct species easily recognized by its peculiar, pointed brown stem with its white root, deeply decurrent spines, and vinaceous-brown, scaly cap. It is new to the South, having been heretofore recorded only from New Jersey and Connecticut. With us it occurs rather rarely in moist deciduous or mixed woods.

Banker has seen our plants and refers them to his *S. Underwoodii* with which they agree well, and they are like the type plants at the New York Botanical Garden and others so determined by Banker. Specimens at the New York Botanical Garden of *H. fennicum* from Italy determined by Bresadola have the same pointed base and surface of cap, but the spines darker, shorter, and decidedly stouter in proportion to length than in our plants described above, in which the teeth are very slender. The spores are smaller than in ours, being about 4.5-5.5 x 5-6.5μ. Other good plants at the New York Botanical Garden from Italy, determined by Bresadola as *H. fuligineo-violaceum,* cannot be distinguished in the dried state from his *H. fennicum* plants just mentioned, except by the still smaller spores which average only about 4.7μ in diameter. Both of these differ distinctly from a good plant of *S. fennicus* from Karsten himself (Finland) which has very delicate slender teeth of a lighter brown color just as in our *H. Underwoodii.* The spores of this specimen seem immature and stick together and to the spines. They are apparently about 5μ in diameter. It would seem that *H. Underwoodii* is the same or very near *H. fennicum* as understood by Karston except for the smaller spores of the latter, while *H. fuligineo-violaceum* as interpreted by Bresadola is a different plant with stouter, shorter, more abruptly pointed teeth which tend to curl in a hook-like manner in drying, and with still smaller spores. Kalchbrenner's fig. (Pl. 32, fig. 2) of *H. fuligineo-violaceum* shows color with little or no violet in it, even in the flesh. The size, shape and abruptly pointed base are very like our plant.*

*American plants determined by Banker as *S. fuligineo-violaceus* (Mem. Tor. B. C. **12**, No. 2, 142. 1906) have since been referred by him to a new species, *S. radicatus* (Mycologia **5**:13. 1913).

PLATE 7

HYDNUM UNDERWOODII. Nos. 1829 AND 1837

1829. Rocky soil by path in woods north of Meeting of the Waters, September 19, 1915. Photo with 1837.

1837. In mixed woods just across the branch from Indian Spring, Battle's Park. September 20, 1915. Photo.

1858. On ground in hardwoods, by Battle's branch, near Strowd's pasture. September 22, 1915.

Asheville. Beardslee.

7. **Hydnum fuligineo-violaceum** Kalch.

Beardslee finds plants at Asheville that are larger than our *H. Underwoodii* and that have a greenish base. They have been referred by Bresadola to *H. fuligineo-violaceum,* and as Beardslee thinks them different from *H. Underwoodii* it seems best to follow Bresadola. In the dried state Beardslee's plants are very like ours and I can make out no difference in the spores. Plants from Bresadola at the New York Botanical Garden, determined by him as *H. fuligineo-violaceum,* (see discussion under *H. Underwoodii*) do not seem to me to be just like the Asheville plants. Beardslee's description follows:

"Pileus 5-12 cm. broad, convex, becoming depressed at the center, and irregularly lobed on the margin, brown or tan, sometimes with a shade of dull red, surface floccose, soon breaking up into small, rather narrow scales; margin thin, fertile, inflexed and irregular. Taste bitter; odor rather strong and not agreeable.

"Teeth small, short, crowded, gray, with the tips white, decurrent.

"Stem rather long, attenuate downward, rough above with rudimentary teeth, white tomentose at the base, which is pointed and becomes dark green within.

"Spores subglobose, 6-7μ, tuberculate.

"I find this everywhere in our woods. Some forms are smaller than the typical forms and seem to present differences. All that I find have the short, crowded teeth, the bitter taste and usually the greenish color at the base of the stipe. I cannot distinguish more than the one species. My plants have been submitted to Bresadola who refers them as above, but says that they vary toward *H. Fennicum.* This is not the plant which Banker refers to *H. fuligineo-violaceum.*" * In a letter of March 17, Beardslee says further: "In my studies of it I have found two forms, one small like yours, and another

*See foot-note on page 172.

larger and rougher, of which I sent you photos and specimens. My feeling is that while your plant can be referred to Banker's species my larger one cannot. It does not dry to a translucent mass, the flesh is far from being 'less than 1 mm. thick when dry,' and the stipe in my plants is always a peculiar green at the base."

8. **Hydnum Murrilli** (Banker)

This species is represented at the New York Botanical Garden by an ample type collection (Murrill and House No. 397) from the mountains of North Carolina. I have examined the plants and find them very near *H. Underwoodii* with the same short, fine teeth; but most of the plants are more infundibuliform than is our *H. Underwoodii* and the color of the dried plant is more yellowish. Further comparison in the fresh state are needed. The original description by Banker follows (Mycologia **5**:15. 1913):

"Hymenophore terrestrial, mesopodous, medium to large size, reddish-brown; pileus expanded to infundibuliform, subrotund to irregular, 5-10 cm. wide, 1-2 mm. thick when dried; surface roughened with fine floccose scales, coarsest toward center, 1-2 mm. wide, ends upturned, about as long as wide, subzonately arranged, dark-reddish brown on scales, lighter between; margin thin, fertile, repand, finely lobed or crenate, pallid; substance fleshy, pale-brown to whitish, drying thin, but somewhat tough and flexible; stem subcentral, strongly inclined, tapering gradually and then abruptly to the base, reddish-brown above, concolorous with pileus, paler below but becoming blackish at the base, scabrous roughened nearly to the base, apparently hollow or stuffed, 4-6 cm. long, 1-2 cm. wide; teeth small, slender, terete, tapering, acute, crowded, decurrent nearly to the base, reddish-brown, white tipped, 1.5 mm. or less long in dried plant, 0.15-0.25 mm. wide, 9-12 to a square mm.; spores subglobose, tuberculate, tubercles not prominent, pale-brownish, 6-7μ wide; basidia prominent, irregular, clavate, 8-10μ wide; sterigmata conical, curved, horn-shaped, 3-4μ long; hyphae of trama hyaline, smooth, thin-walled, collapsing when dried, recovering in KOH, subparallel but partly separable in KOH, septate, without clamp-connections, segments

short, stout, constricted at the septa, irregular, 10-28μ wide by 20-70μ long; hyphae of the teeth very slender, tubular, rarely septate, 3-4μ wide."

9. **Hydnum roseolus** (Banker)

The following species, found by Murrill and House in the mountains of North Carolina and known from no other station, is described by Banker. I have been through the *Hydnums* in the New York Botanical Garden, but have not been able to find any part of the type (M. and H. 392) on which the species is based. The following is the original description (Mycologia **5**:16. 1913):

"Hymenophore terrestrial, mesopodous, gregarious, small to medium size, 4-6 cm. high, pale-rose-color; pileus plane to convex, 3-4 cm. wide, 0.5 cm. or less thick; surface pubescent and slightly imbricate, scaly, even, whitish tinged with old-rose; margin thin, incurved when dried; substance fleshy-tough, drying into two layers, an inner waxy and gummy, subtranslucent layer, and an outer dry, opaque, subfibrous layer; stem slender, subcentral, strongly inclined, subeven, slightly radicating, scabrous, 2-3 cm. long by 7-10 mm. wide; teeth very short, terete, tapering, acute, uniform, decurrent and abortive on the stem, not crowded, 0.3-0.7 mm. long by 0.1-0.2 mm. wide, 16-20 to a square mm.; spores pale-brown, tuberculate, ovoid, 4-5 x 5-6μ wide; basidia clavate, four-spored, 5-6μ wide; sterigmata slender, capillary, 3μ long; hyphae of inner portion of pileus clouded, smooth, slender, thin-walled, collapsing when dried, recovering in water and KOH, forming a somewhat intricate and compact tangle, scarcely separable in KOH, septate, without clamp-connections, segments long, irregular, subtubular, 4-7μ wide, contents granular; hyphae of outer portion of pileus more even, tubular, and coiled."

10. **Hydnum fumosum** (Banker)

This species, known only from the mountains of North Carolina, is evidently quite different from any other American *Hydnum*. The type collection is in the New York Botanical Garden (Murrill and House, No. 394). The description by Banker follows (Mycologia **5**:16. 1913):

"Hymenophore terrestrial, mesopodous, small, 3-5 cm. high, ash-gray to smoky; pileus plane to convex, 2-3 cm. wide, 2-3 mm. thick; surface even, subpubescent, ash-gray to smoky-olivaceous-brown when dried; margin thin, fertile, minutely serrate; substance fleshy-spongy when fresh, somewhat tough, flexible, compact, subwaxy toward surface, soft fibrous within, olivaceous when dried; stem slender, subcentral, inclined or curved, attenuate upward, subpubescent at base to glabrous shining toward the cap, 2-4 cm. long, 3-10 mm. wide; teeth short, slender, terete, tapering, acute, uneven, not decurrent, pale to dirty-white, somewhat crowded, 2-5 mm. long or less, 0.2-0.4 mm. wide, 9-12 to a square mm; spores dark, coarsely and densely tuberculate, ovoid, 7-9μ x 9-11μ wide; basidia clavate to oblong, narrowing abruptly at the base, 7-10μ wide by 25-30μ long; sterigmata delicate, conical, incurved, 3-4μ long; hyphae of trama colored, dissolving out freely in KOH, becoming hyaline, slender, smooth, thin-walled, collapsing when dried, recovering slightly in KOH, forming an intricate tangle but slightly separable in KOH, septate without clamp-connections, segments extremely long, somewhat irregular, more or less constricted at the septa, 4-6μ wide; hyphae of the teeth very slender, parallel, 3-4μ wide; taste bitterish."

GENUS MANINA.

Plants without cap and stem, solid and tuberculate or intricately branched; teeth long, hanging from most of the body; texture fleshy and soft; growing on wood.

KEY TO THE SPECIES.

Solid and nearly simple.....*M. cordiformis* (1)
Repeatedly branched .....*M. flagellum* (2)

1. **Manina cordiformis** Scop. Satyr's beard Hydnum.
Hydnum erinaceum Bull.

PLATES 8 AND 27.

This is our largest species of the family and it is rather common on rotting places in living deciduous trees in fall, mostly on oak, rarely on beech. It is also occasional on dead trees. It does not branch in

PLATE 8

MANINA CORDIFORMIS. No. 1296. REDUCED

a complex manner like the coral Hydnum, but forms a heavy, solid mass that is covered with long, fleshy, parallel, pendant spines. It projects laterally from a narrowed point of attachment and requires several weeks to attain its full size, which is often several pounds in weight. The color is creamy-white or yellowish and it turns brown on drying. The spores are smooth or perhaps very minutely rough, spherical to subelliptic, 4.8 x 5.5μ, or when spherical about 5μ in diameter.

This species is said to be very variable, but in Chapel Hill it is unusually constant in its appearance. Only one of our collections (No. 295) varied in shape towards the form called *M. caput-ursi*. It is easily distinguished from *M. flagellum* both in form and in the larger spores. Edible.

295. On wood in Battle's Park, October 28, 1910.
526. At base of a small oak tree in woods east of schoolhouse, October 8, 1912.
627. Rotting place in beech tree near Battle's Branch back of Dr. Wilson's, October, 1912.
988. On dead place in a live tree, Battle's Park, near Piney Prospect, October 16, 1913.
1277. On a dead place on an oak, southwest of athletic field, September 28, 1914. Photo. Spores subelliptic to spherical.
1296. At base of a dead oak, south of cemetery. Spores white, spherical to subspherical, smooth, one large oil drop, 5.1-5.9 x 5.1-6.4μ.
1249. On rotting log in woods south of athletic field, October 14, 1914.
1250. On dead oak log in woods east of Graded School, October 15, 1914.
1401. On a dead, but rather solid oak log, 1/8 mile below Meeting of the Waters, October 21, 1914.

Asheville. Beardslee.
Common, base of trunks. Curtis.

2. **Manina flagellum** Scop.
Hydnum ramosum Bull.

PLATES 9, 10, AND 27.

When fresh and perfect this is one of the most beautiful of fungi and is a picture of exquisite delicacy. It grows from dead wood in an intricately branching mass up to about 12 cm. wide, pure white throughout and extremely fragile. The whole surface

is covered with innumerable, short, glistening-white, pendant spines about 5.8 mm. long. Spores (of No. 1447) spherical to subelliptic, smooth, pure white, clear, one oil drop; 3.7-4.6 x 4.4-5.3μ. Edible.

This species may be distinguished from all others by its much branched character, its delicacy and snowy whiteness, and by the distribution of the spines over the entire plant. This is certainly the form that passes under the name given above (see Banker, in Mycologia 4:276. 1912). It is probable that the *M. coralloides* is nothing more than another growth form of this. It is certainly distinct from all forms of *M. cordiformis* which has a solid, bulky body and larger spores.

296. Battle's Park on a dead log, October 3, 1910.
1447. On dead log just below woods road, south of cemetery, October 29, 1914. Photo.
1984. On a dead hickory about 10 feet from the ground, Battle's Park, November 12, 1915.

Blowing Rock. Atkinson.
Common, side of trunks. Curtis.

GENUS STECCHERINUM.

Plants with distinct cap, which is usually laterally sessile or more or less distinctly stalked, occasionally partly resupinate; texture tough and fibrous; growing on wood.

KEY TO THE SPECIES.

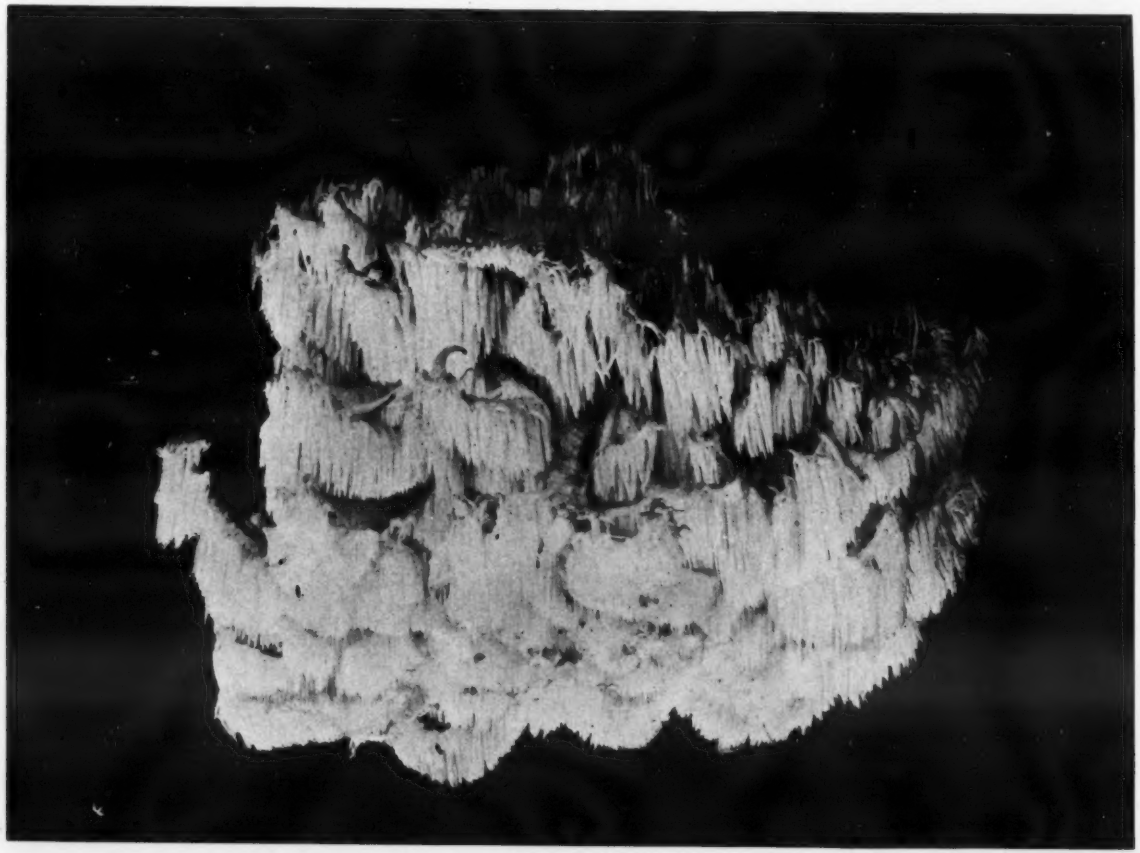
Cap strongly tomentose.
  Color light grayish-brown; flesh dry.....*S. Rhois* (2)
  Color light buff at maturity; flesh juicy.....*S. pulcherrimum* (1)
Cap smooth or very minutely tomentose.....*S. adustum* (3)

1. **Steccherinum pulcherrimum** (B. & C.) Banker

PLATE 11.

Caps expanded, horizontal, imbricated and partly confluent, entirely sessile from a resupinate base; individual caps about 4 cm. wide, 2-2.5 cm. thick at base, quickly thinning towards the margin. Surface densely fibrous, whitish when young, turning light buff or rosy buff. Flesh white, fibrous, tough, elastic and fleshy, 1.5-2 mm. thick at base, about 4 mm. thick near the rather blunt margin, almost

PLATE 9



MANINA FLAGELLUM. No. 1447

PLATE 10

MANINA FLAGELLUM. No. 1984. REDUCED

tasteless, but with a faint odor resembling that of preserved figs; when dry it is very soft, light and fibrous and if wet and pressed between the fingers it has a gummy feel.

Spines dense, crowded, slender, 2.5 mm. long at base, 1 mm. long near margin, whitish then light pinkish-buff, extending downward on the resupinate portion.

Spores said by Banker to be oblong, smooth, granular, hyalin, 2-2.5 x 4.5-5μ, very transparent with one or more dark granules.

A plant very like the above was sent to Fries by Curtis and named by the former *Hydnum friabile.* Lloyd thinks he has recognized the latter species in a plant sent to him from New York (*Letter* **65**, p. 7). From his description of the flesh, which is of the same nature as that of *Polyporus sulphureus,* our plant is not that species, as in the latter the plant is composed of very loosely woven parallel fibers and is not mealy. Also see Lloyd's *Letter* **65**, p. 10, for comparison of *H. pulcherrimum and H. septentrionale.* Banker thinks *S. friable* and *S. pulcherrimum* the same (Mycologia **5**:294. 1913).

1254. On a rotting oak stump in grove back of President's house, September 24, 1914. Two photos. No spores obtainable.

2. **Steccherinum Rhois** (Schw.) Banker

PLATES 12 AND 27.

Plants elastic, tough, shell or kidney-shaped, sessile by a constricted base, sometimes confluent, up to 3.5 cm. by 2 cm. in size; surface densely felted—hairy, the felt collapsed in places, distinctly zonate, color a rather light grayish brown with zones of different shades, the marginal half somewhat darker; margin sterile for about ½ mm. The color and appearance is so like that of the lighter shaded plants of *Lenzites betulina* as to be indistinguishable in passing. Context of two distinct parts, a dense, firm, elastic layer, which is about ½ mm. thick and colored like the teeth, and a soft, densely felted upper layer, colored like the surface and varying from less than ½ to as much as 1.5 mm. in thickness.

Spines ochraceous tawny (Ridgway), crowded, short (1-1.5 cm. long), tapering somewhat towards the tip, but truncate and more or less blunt at the ends, which are fimbriated on their margins and

sometimes over the entire surface. In section, as shown by the truncated tips, the teeth are irregular and more or less angular, varying considerably in size and often several fusing.

Spores (of No. 1511) white, oblong-elliptic, smooth, clear, minute, 1.8 x 3-3.8μ.

Growing on dead wood of deciduous trees.

87. On a stump, meadow at foot of Lone Pine Hill, October 14, 1911.
1511. On fallen branch of white oak in Professor Howell's yard, December 10, 1914. Photo.

Common, stumps and sticks. Curtis.

3. **Steccherinum adustum** (Schw.) Banker

PLATES 13 AND 28.

Plants growing on logs, sessile or stalked, at times resupinate in part, simple or complicated by others springing from the back of the lower ones near the point of attachment. Cap up to 8 cm. wide, roughened and uneven with low ridges and channels and sometimes with nodules, minutely velvety, or smooth in places, white or faintly tinted with creamy-flesh or light tan, smoky when rubbed and often dark on the margin; circular or fan-shaped, the margin very thin and wavy. Flesh pure white, tough and elastic, 2 mm. thick near center, tasteless and odorless.

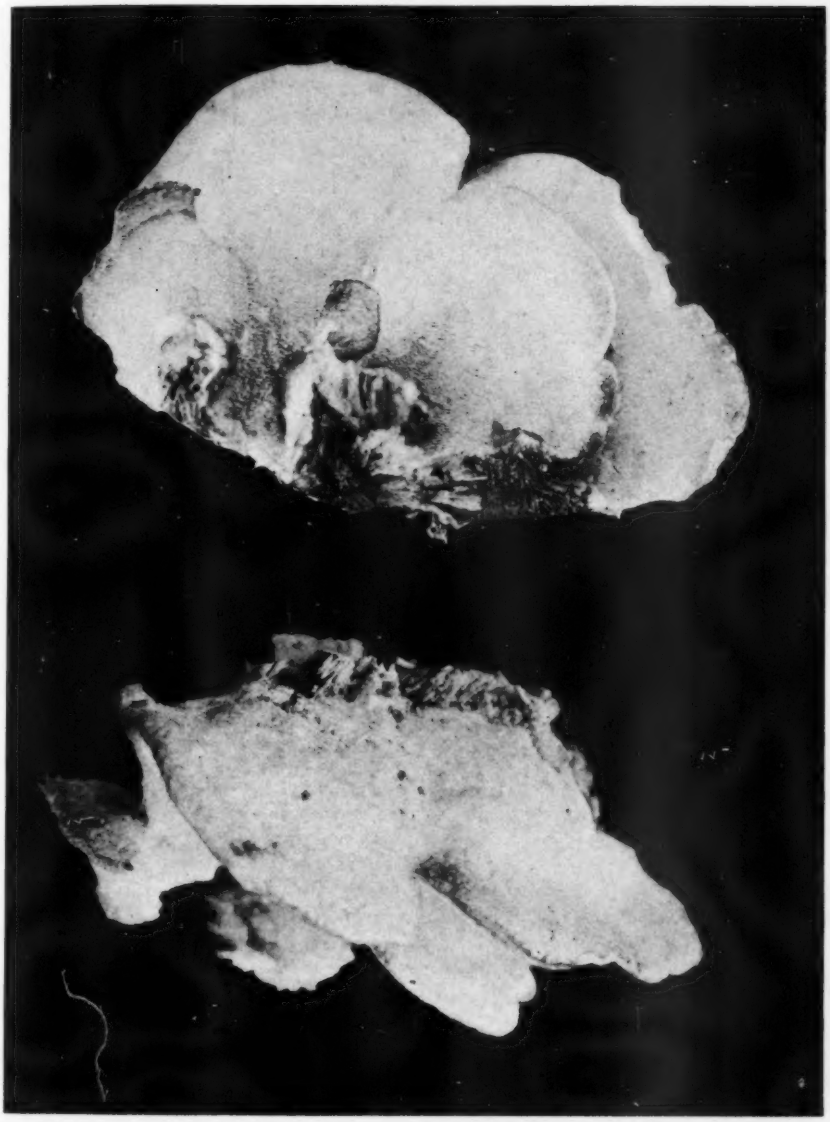
Stem entirely absent with the cap laterally attached, or with a short but distinct stem which is eccentric or lateral or rarely central. It is up to 1 cm. long and very variable in size, velvety, white or discolored.

Teeth about 1.5-3.5 mm. long, more or less flattened, and *generally branching near the tips into several processes,* white at first, then turning quickly when drying to a clear and beautiful rose color, then purplish rose, and in age a dark cinnamon-brown. If bruised when fresh the teeth turn to a deep smoky color due to the fact that they are covered with minute hairs, visible only under the microscope, and these hairs when bruised turn almost black.

Spores (of No. 1607) white, long-elliptic, smooth, minute, 1 x 3μ.

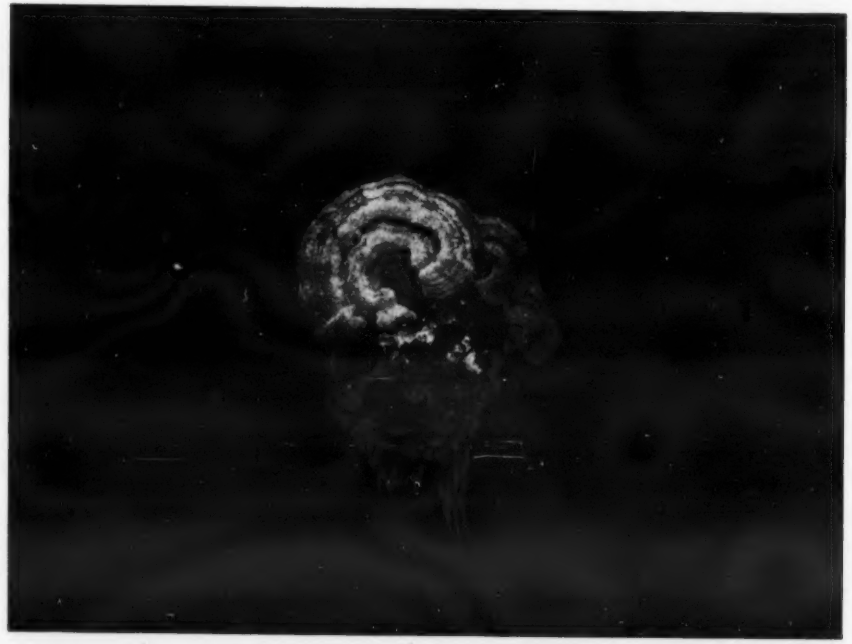
Growing on rotting wood.

PLATE 11



STECCHERINUM PULCHERRIMUM. No. 1254

PLATE 12



STECCHERINUM RHOIS. No. 1511

PLATE 13

STECCHERINUM ADUSTUM. No. 1219

86. On a dead oak limb behind athletic field, October 20, 1911.
293. Woods near Chapel Hill.
350. At base of stump, Battle's Park, October 8, 1911.
1219. On dead oak branches, swamp of New Hope below Durham bridge, July 27, 1914. Photos.
1235. On rotting wood by branch above Meeting of the Waters, September 21, 1914.
1607. On rotting wood in three clumps, two below Strowd's Spring, the other above Durham bridge, June 23, 1915.
2012. On stump by street near Dr. Herty's, November, 1915.
2243. On a deciduous log, swamp of New Hope Creek, below Durham bridge, June 24, 1916.
2313. On rotting wood near mouth of Tenny's Ravine, June 29, 1916.

Middle and upper districts, on sticks. Curtis.

GENUS HYDNELLUM.

Plants with cap and stem, but often deformed or fused; texture tough, in some species thin and homogeneous, in others thick and composed of two layers of different texture; spores unevenly tuberculate. Growing on the ground. The genus cannot be distinguished from *Phellodon*, except by the spores, and this is by no means easy even for experienced students.

KEY TO THE SPECIES.

Flesh thin, homogeneous, tough and flexible when fresh; plants small to medium.
  Cap strongly zonate, thin, margin pale and often pinkish ..... *H. zonatum* (4)
  Cap scarcely zonate, less thin, margin not whitish ..... *H. scrobiculatum* (3)
Flesh rather thin, homogeneous, fleshy-tough and flexible; plants usually large..... *H. humidum* (8)
Flesh thick and of two textures, soft and spongy above, hard below.
  Color a deep orange-salmon, at least on younger parts ..... *H. floriforme* (5)
  Color not as above.
    Taste peppery, odor of fenugreek..... *H. diabolus* (1)
    Taste not peppery.
      Cap creamy buff, the center becoming brown.
        Plant compact and heavy..... *H. ferrugipes* (6)
        Plant light and slender..... *H. carolinianum* (7)
      Cap cinnamon brown, plane or convex, the margin pale when growing..... *H. velutinum* (2)
      Cap grayish umber, depressed or infundibuliform ..... *H. Nuttallii**

*See foot-note on page 183.

1. **Hydnellum diabolus** Banker

PLATES 14, 15, AND 28.

Plants short and stout, gregarious and often confluent. Rather common on ground in pine woods, particularly in autumn.

Caps up to 15 cm. broad, flat, sometimes nearly smooth, but usually with low waves and protuberances, and irregular on the margin; soft and minutely tomentose-felted all over. Color a pretty, light salmon-flesh tint when young and fresh, or often nearly pure white on margin, changing from center outward to a vinaceous-rust color (almost sorghum brown of Ridgway) with blackish stains where rubbed, particularly on the margin, in age becoming a deep sordid brown from center outwards. Flesh thick in center, distinctly zonate, blunt on margin, about color of cap but when quite fresh turning blackish instantly when cut; quite soft near the upper surface, and gradually getting firmer towards the spines. The watery juice of our plants is not reddish but colorless, but Underwood found plants of *H. diabolus* in Alabama with very red juice, and the species is described by Banker as having a red juice, but Banker now considers the juice color as of little or no taxonomic importance (see Mycologia **5**:197. 1913). The odor is pleasant and aromatic (fenugreek) when fresh, but this often disappears in drying. Taste quite peppery. All parts of the plant tend to become blackish when bruised.

Spines very short near the margin, 4.5 mm. long near the stem, somewhat decurrent, color of cap on margin, turning through light vinaceous salmon to russet vinaceous then sorghum brown and finally to a deep chestnut brown.

Stem short, stout, irregular and dropsical in appearance, deep russet brown even when young, 1.5-2.5 cm. long and often as thick as long, flesh at upper end like that of cap, becoming harder and darker at bottom. No distinct superficial layer, but the surface is soft, the flesh gradually hardening inwards. The texture of the plant is much like that of *P. amicus,* except that the soft surface layer is not so distinct from the firmer inner part as in that species.

HYDNELLUM DIABOLUS. No. 1341

PLATE 15

HYDNELLUM DIABOLUS. No. 1951

Spores (of No. 1341) light vinaceous brown; roughly spherical to elliptic, strongly angular, a large oil drop, 3.7-4.3 x 4-5μ. For the original description of this species see Mycologia **5**:194. 1915.

1341. **In pine woods by path leading to Meeting of the Waters from road east of cemetery, October 14, 1914.**

1869. **Growing in Battle's Park, near branch, in pine woods, September 22, 1915.**

1951. **Under *Pinus inops* on hillside north of King's milldam, October 31, 1915. Photo. Exactly like 1341. Odor of fenugreek, taste strongly peppery. One plant 15 cm. in diameter.**

1968. **Growing in pines by a woods road near Mason farm, November 7, 1915.**

2. **Hydnellum velutinum** Fr.*

Hydnum spongiosipes Pk.

PLATES 16 AND 28.

Cap about 3-7.5 cm. broad, often confluent with others, convex or plane, or often slightly depressed in center, usually irregular in shape with the surface more or less grooved, pitted and complicated by eruptions, but without the rough and harshly complicated centers of *H. scrobiculatum,* without zones or with a few faint zones of shades; surface finely tomentose, plush-like when young and also in age unless too much wet or handled; color after maturity cinnamon brown all over with a lighter sheen from the surface tomentum when quite fresh, blackish-brown when bruised, the margin not lighter except when wet; when quite young the cap tomentum is nearly white, and the margin remains whitish (very light fleshy-brown) as long as it is growing, the older central part soon becoming dark. Flesh of two textures, a soft spongy upper layer about 1-6 mm. thick, colored like the surface, and a thin, darker, tough, and much harder lower layer; when fresh the flesh is full of a clear watery juice which in our plants is not at all pink; taste and odor not strong, hardly disagreeable, somewhat like rotting wood, when young and fresh faintly like ripe cucumbers, no fenugreek or pig-pen odor.

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*HYDNELLUM NUTTALLII Banker.

A plant collected by Atkinson in the mountains of North Carolina is referred to this species by Banker, who says that it "differs in some respects from the type but in characters that seem to be accounted for by the fact that the plant was old and dead when collected." We have not seen the plant, but the species is said to differ from *H. velutinum* "in the form of the pileus, in the subrugose not tomentose surface, and in the long capillary teeth." For the full description, see Memoirs Torr. Bot. Club **12**, No. 2:155. 1906.

Spines sharp, slender, rather crowded, about 3 mm. long, shorter at stem and fading away towards the sterile margin, slightly decurrent, light brown on the margin, deep cinnamon brown elsewhere, darker when bruised; when still growing the marginal ones are the color of the cap margin.

Stem central, short or of moderate length, 1.4-3.5 cm. long, 8-13 mm. thick at cap, much thickened below by an irregular surface mass of spongy tissue which surrounds and binds surrounding trash, and is often confluent with adjoining plants; surface colored like the cap and of the same plush-like tomentum; flesh hard inside, soft and spongy towards the surface.

Spores (of No. 2401) brown, roughly globose and tuberculate, 4-6μ. See drawing.

These are thought by Banker to be the same as *H. velutinum* Fr., and after careful examination of a plant from Italy (Bresadola) in the New York Botanical Garden I quite agree with him. The appearance is the same, and the spores are identical. See drawings.

1367. Mixed woods on hillside near branch, about 30 yards below Judge's Spring, October 14, 1914. Odor slight, woody.

1606. On ground among leaves under a hickory tree just north of Piney Prospect. Spores subspherical, coarsely tuberculate, about 5-5.5μ, exactly like the spores of 2401. This is much like *H. diabolis* except that the taste is not peppery but slightly acid with a woody flavor, juice watery.

2401. Low place in mixed pine and deciduous woods, near Meeting of the Waters, July 20, 1916. Photo.

2412. Pine and deciduous woods near Battle's Branch, July 22, 1916.

2424. Under pines mixed with oaks near the top of Lone Pine Hill, July 26, 1916. Spores subspherical, coarsely tuberculate, about 5μ in diameter, just like those of No. 2401.

Blowing Rock. Atkinson.
Middle district, woods. Curtis.

3. **Hydnellum scrobiculatum** Fr.

PLATE 28.

Plants growing on soil in woods, gregarious and often compound by fusion, individuals about 3-8 cm. wide, compound individuals

PLATE 16

HYDNELLUM VELUTINUM. No. 2401

sometimes larger. Cap rather flat but irregular with pits, proliferations and asperities, at times with more or less distinct radiating ridges, the center very rough like scoria with sharp points and pits, minutely velvety, tomentose or smoothish in places, with faint structural zones; color a uniform cinnamon brown, deeper brown when bruised. Flesh usually thin, very tough and firm except for a very thin superficial felty layer, which tends to disappear in places; brittle and hard when dry; taste and odor slight; no odor of fenugreek.

Spines sharp, slender and crowded, about 3-5 mm. long, short and fading away towards the sterile margin, at first pallid and then a deep brown color; somewhat decurrent.

Stem usually slender and short, up to 3 cm., mostly about 2 cm., long; surface about color of cap, covered with a thin layer of soft spongy tissue which surrounds and binds adjoining particles; center hard and tough.

Spores roughly globose, unevenly tuberculate, about 4-4.8 x 5μ in diameter.

This species is most like *H. zonatum*, from which it is distinguished by the thicker and more rigid substance, by the nonzonate and much rougher cap, the center usually with sharp pits and proliferations like scoria. Our plants look just like Fries' figs. (Plate 5) and like several collections under this name at the New York Botanical Garden.

292. **Low place in deciduous woods with scattered pines southeast of athletic field, September 25, 1908.**

4. **Hydnellum zonatum** (Batsch) Karst.

PLATES 1, 17, 18, AND 28.

Plants terrestrial, thin, pliable and toughish, gregarious and often concrescent in groups, what appears to be one cap from the surface often having several stems. Cap up to 7.3 cm. wide, usually 3.5-6 cm., nearly plane, commonly somewhat depressed in center, sometimes, as in No. 1323, extremely rugged and complicated with the center filled with deep pits and pointed projections; margin a pretty,

clear flesh-pink or onion-skin pink, darkening by distinct zones through pinkish-cinnamon brown to deep Vandyke brown or pecan brown in center; radiating ridges are usually rather distinct. Flesh thin, firm, tough, homogeneous, but zoned, color of surface, about 3 mm. thick near center, very thin towards margin; taste and odor woody, or, in No. 1849, faintly like that of *Mutinus*.

Stem usually short, 0.5-2 cm. long, 4-6 mm. thick at top, much stouter below, pinkish when young and then darkening like cap. Flesh solid and same texture throughout, somewhat harder than the cap, darker than the surface when young, of the same color when old.

Spines small, rather blunt, not fimbriated. From 1-2.5 cm. long, pinkish on the very edge, but soon becoming a deep rich brown like the darkest parts of the cap.

Spores (of No. 1238) light smoky-purple, subspherical, coarsely tuberculate, one large oil drop, 3.4-5μ in diameter.

While our plants show the pink margin in most cases it is well to note that this color may not be observable when the plants are collected.

These plants would seem to be as easily referred to *H. vespertilio* as to *H. zonatum*, except for the absence of the scabrous yellow dots that Banker says are characteristic of that species (Mycologia **5**:199. 1913). Perhaps the two species are not distinct. *H. concrescens* is also very near if not the same.

297. Battle's Park, by path near Dr. Battle's house, September 21, 1908.

297*a*. On a bank near Howell's Spring, October 23, 1911. Spores 3.5-4.5 x 4-5.5μ.

827. Mixed woods, Battle's Park, September 23, 1913.

1238. Growing in rather sandy soil by branch 100 yards above the Meeting of the Waters, September 21, 1914. Photo and painting.

1323. On ground near branch due east of Dr. Battle's, deciduous woods with a few scattered cedars, October 9, 1914. Photo.

1346. Woods east of graded school, October 15, 1914. Spores a smoky-purple color, very irregular in shape with tubercles and angles, one oil drop, 4.2-5μ in diameter.

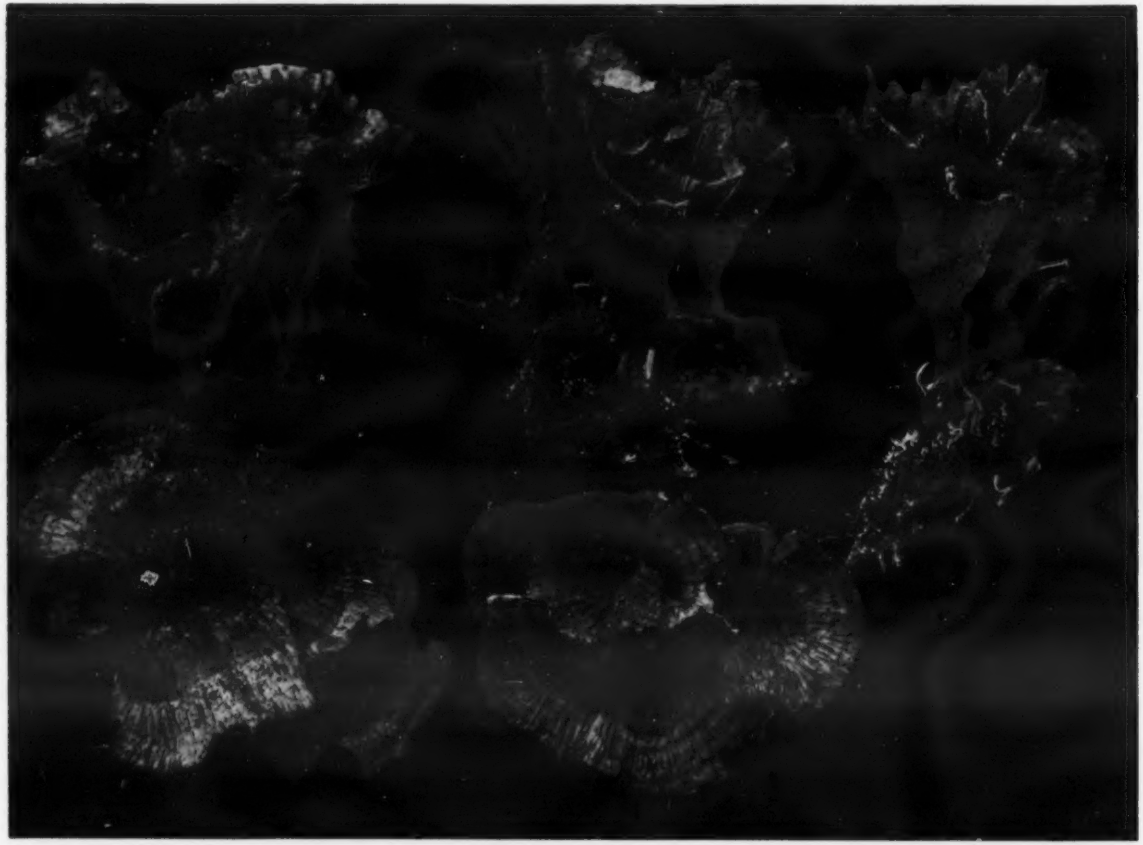
1849. By path along branch north of Meeting of Waters, September 15, 1915. Odor distinct, not of fenugreek, but faintly like that of *Mutinus* although not very disagreeable. Plants extremely thin, pliant, flesh 1 mm. thick, spines 1 mm. long.

PLATE 17

HYDNELLUM ZONATUM. No. 1849

PLATE 18

PLATE 18



HYDNELLUM ZONATUM. No. 1323

1241. Among pine needles by path along Battle's Brook, September 19, 1914. Painting and photo.

1244. Among oak leaves in wooded pasture about one-half mile west of graded school, September 22, 1914.

1847. Under pines, Battle's Park, near second bridge above Indian Spring, September 20, 1915.

Middle and upper districts, hillsides. Curtis.

6. **Hydnellum ferrugipes** n. sp.

PLATES 21 AND 29.

Plant solid and heavy, of medium size, our specimens about 4.5-5.5 cm. broad, the cap rather regular and only slightly lobed or complicated, slightly to distinctly depressed in the center, the blunt margin sterile and pale below; surface finely felted tomentose or on expansion mostly smooth, even or more or less pitted, not zonate, color pale buff or dull tan or mottled with deep brown on exposure, the growing parts becoming blackish when rubbed. Flesh zonate towards the margin, duplex but not so sharply contrasted as in *H. velutinum, P. amicus,* etc., a rather thick, buffy upper layer of a firmly corky texture, passing more or less abruptly into a hard and darker brown layer below. Odor very faint, slightly musty, as is also the taste.

Spines up to 4 mm. long, not very slender, rather bluntly pointed when fresh, sharper when dry; pale grayish at the margin, passing through light to dark gray-brown, with a tint of salmon at times, and then to deep brown, the tips pallid until age.

Stem short, about 2-3 cm. long and 1-1.5 cm. thick, rusty red, the context consisting of a very hard and rather slender core of dark, distinctly longitudinal fibers, surrounded by a rather thick woody-corky layer of more radiating fibers of a reddish brown or rust color, only the surface of which is distinctly soft.

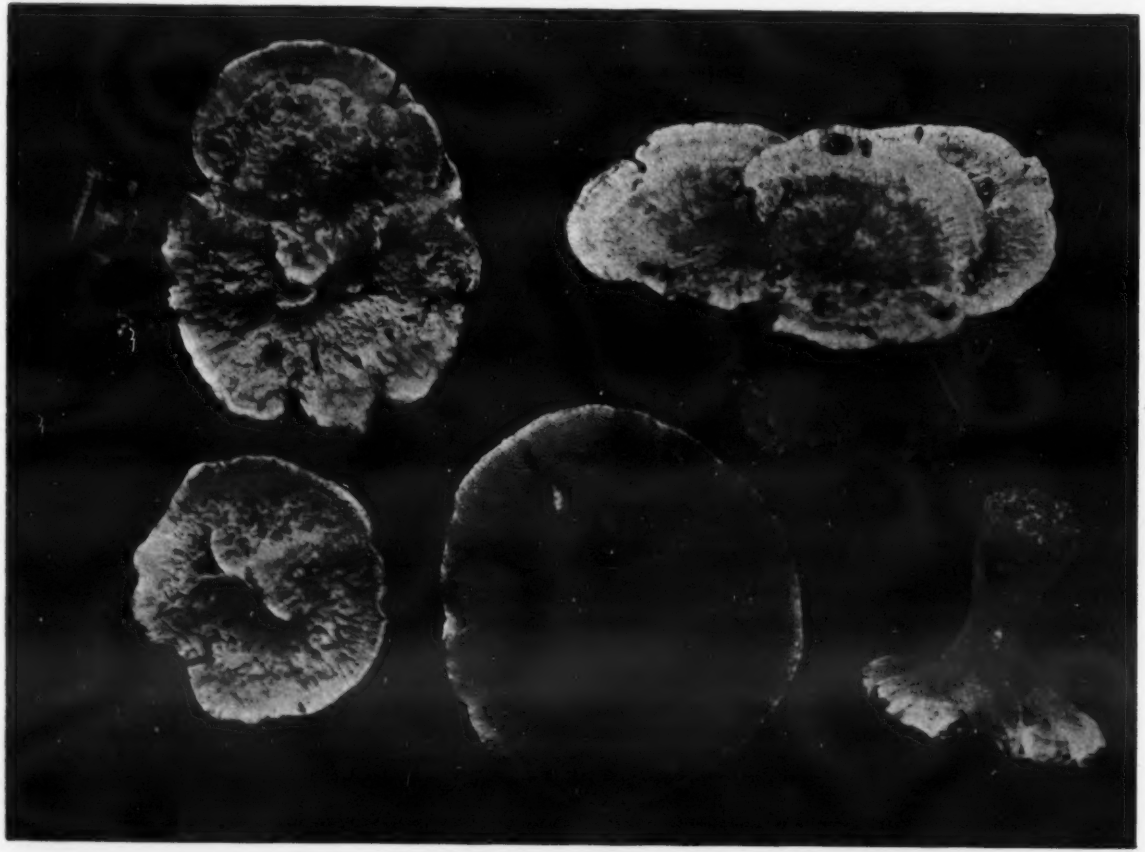
Spores (of No. 3201) subspherical, smoky brown, papilliate-warted, 4.6-5.6μ, some more elongated as 4.5 x 6.5μ.

Differs from *H. floriforme* in pale color, in thicker and more compact flesh, in longer and stouter spines, in absence of a fragrance and in the distinctly larger spores. *Hydnellum complicatum* Banker differs in color and in the thinner cap and smaller spores. Shaeffer's

PLATE 19

HYDNELLUM FLORIFORME. No. 1241

PLATE 20



HYDNELLUM FLORIFORME. No. 1244

PLATE 21

PHELLODON FERRUGIPES. No. 3201 (left), No. 3211 (right)

figures (Plate 146, figs. 1, 2, 3, 5, and 6) which Persoon refers to his *H. compactum* look much like our plants and I have seen no other figures that do. Fries' conception of *H. compactum* is not so different from our plant it would seem, except that in the latter there has not been noted any olivaceous tint to the cap or bluish mottling in the flesh. Banker thinks that the *H. compactum* of Persoon is probably the same as *H. floriforme* and not the plant now referred to the former species by European botanists today.

3201. In sticks and leaves of deciduous woods, low place east of athletic field, October 7, 1918. Photo. Type.

3211. Deciduous woods by Battle's Branch, October 3, 1918. Photo with No. 3201.

7. **Hydnellum carolinianum** n. sp.

PLATES 1, 22, AND 29.

Individual plants 1.5-5 cm. broad, the stems (in No. 1243) quite distinct and not confluent, but often branching at top into two or several crowded and more or less fused caps, or (in No. 1847*a*) several short-stalked caps may arise from a fused basal stratum which is deeply rooted. Surface smooth, not ridged or scrobiculate, usually convex, or the margin later becoming uplifted, closely felted-tomentose in unweathered parts, the margin undulate and lobed. Color of fresh, unweathered plants and growing margins of weathered ones a pale creamy buff (between pale yellow orange and white—Ridgway), which fades and deepens on exposure to rain to a sordid rusty brown with a tint of chocolate, and then in age to nearly black. Flesh duplex, the outer layer soft and spongy, buffy yellow and about 1-3 mm. thick; the much harder lower layer usually thinner and a lighter grayish brown color; odor almost none; no decided taste (not sour or peppery). After exposure to rain the soft flesh collapses and hardens like horn either in whole or in part, the horny, black layers being separated by lighter zones.

Spines slender, short, reaching a length of about 2 mm., when young whitish (nearly color of young cap at very margin), the main length below the tips soon turning a dark rusty brown (natal-brown—

Ridgway). The brown can be seen showing through the white surface view and gives the effect of grayish-brown to the spine surface. In age the brown encroaches still more on the white tips, but for a long time there is the effect of gray over brown. Finally the white fades entirely away and the whole becomes a deep natal-brown (almost chocolate brown).

Stem distinct, 3-4 cm. long, 0.8-2 cm. thick, irregular and dropsical in appearance; surface colored like the deeper brown shades of the old cap and spines, becoming blackish. Flesh composed of two distinct layers, a soft, spongy, water-soaked outer layer about 2-3 mm. thick which grows around and catches the trash and leaves that touch it, and a much firmer, sordid yellow-brown interior part which is zoned with darker lines.

Spores purplish-brown, subspherical, roughly and irregularly warted and angled, one large oil drop, 3.7-4.6μ in diameter.

This plant seems to be the southern representative of *H. suaveolens*. Dried plants of the two species are very similar except for the longer stems and absence of bluish or lavender zones in the flesh of our plants. However, I notice that dried plants of *H. suaveolens* often fail to show any obvious blue or violet tint to the darker zones, and I find a plant from Finland at the New York Botanical Garden (from Karsten) that has as long a stem as ours and could scarcely be distinguished from them, except for the dark purplish color of the stem surface and flesh. I have no notes on the color of the mycelium of our plants, but it could hardly be purple as that would have attracted my attention. As *H. suaveolens* is considered as distinctly a northern plant, appears to affect coniferous woods and is often quite large, it does not seem possible to refer our plant to it.

Absence of peppery taste and habitat in oak woods easily distinguish this species from *H. diabolus*. The plants are also smaller than that species and have longer stems in proportion to size. It cannot be *P. alboniger* as the black core is entirely lacking. It differs from *H. amicus* in the absence of a fetid odor and in the warty and not spinulose spores, which are also of a different color. From *H. velutinum* it differs in the lighter color, different odor, smaller spores, and in the fact that dried plants if put in a tumbler with enough water to cover

PLATE 22

HYDNELLUM CAROLINIANUM. No. 1242

will turn the water a deep brownish wine color in a short time, while plants of *H. velutinum* will turn the water only a pale cider color. The dried plants have no odor. When soaked again they have a faint rather pleasant odor, while in *H. velutinum* the odor is not restored on wetting the dried plants.

1243. Among oak leaves in open woods, one-third mile west of graded school, September 22, 1914. Photo and drawing of spores. Type.
1847*a*. In moss in mixed woods near Battle's Branch, September 20, 1915.

8. **Hydnellum humidum** Banker
Hydnum infundibulum Swartz. ?

PLATES 23, 24, AND 29.

A large, thin, expanded plant with a slender central or eccentric stem, often compound by fusion, growing in woods-mold near branches or springs or in depressions in deciduous woods. Cap up to 10 cm. wide, irregular, rough with radiating ridges and channels, more or less infundibuliform, especially in youth, in age usually depressed in center with the margin broadly expanded and more or less drooping; rather obscurely zonate; color light snuff-brown, near sayal-brown (Ridgway), with lighter zones towards margin, in old age turning deeper blackish-brown to black; margin repand and irregular, whitish, fertile. Flesh thin, fibrous-fleshy, firm and brittle on drying, only 1.5-2 mm. thick, except towards center; homogeneous (no spongy upper layer), no noticeable taste or odor.

Spines densely crowded, short, 1.5-2 mm. long, delicate, whitish at the tips to maturity, then becoming brown all over.

Stem 3-4 cm. long, 8-10 mm. thick above, enlarged and irregular below, color of cap.

Spores (of No. 1306) light smoky-brown, subspherical, roughly tuberculate, 3.4-5μ.

While the substance of the cap is somewhat fleshy, it is tougher and much thinner than in species of *Hydnum* or *Sarcodon*. Plants at the New York Botanical Garden of *Hydnellum humidum* from New Jersey, determined by Banker, look very like the above plants and show the same tendency to be quickly attacked by grubs and mold.

The large, thin zonate cap and very short spines are strikingly similar. The spores also are the same as in our plants, averaging about 4.5μ in diameter. Some of the New Jersey plants are strongly infundibuliform. Beardslee's plants, which he refers to *H. infundibulum*, seem the same as mine.

1306. By a spring near Meeting of the Waters Branch, about one-eighth mile above Scott's Hole, October 2, 1914. Two photos. Drawing of spores.
1856. On leaf mold on a rock by Battle's Branch (not near pines), September 22, 1915.
3220. In low place in deciduous woods east of athletic field, October, 1918. Many plants, all old and dead.

Asheville (as *H. infundibulum*). Beardslee.

GENUS PHELLODON.

This genus is like Hydnellum except that the spores are papillate or echinulate instead of warted. For all practical purposes it would be better to combine the two, and I retain Phellodon here only because Banker is describing a new species and prefers to recognize the genus.

KEY TO THE SPECIES.

Plants very small (up to 1.5 cm. broad), mouse colored ..... *P. Ellisianus* (5)
Plants averaging larger
  Flesh homogeneous
    Odor of fenugreek ..... *P. Cokeri* (4)
    No odor of fenugreek ..... *P. tomentosus* (3)
  Flesh spongy above, hard below, odor strong in drying
    Hard flesh black ..... *P. alboniger* (2)
    Hard flesh not black ..... *P. amicus* (1)

1. **Phellodon amicus** (Quel.) Banker
Hydnum putidum Atk.

PLATES 25 AND 29.

Plants reaching a size of 10 cm. broad and the same height, but usually smaller; caps and stems easily fusing into compound indi-

PLATE 23

SYNNEMATIUM SUMATRENSE. No. 2206

PLATE 24

HYDNELLUM HUMIDUM. No. 1306

viduals. Cap very irregular, warted, pitted and channeled, usually depressed in center; surface with a fine, plush-like tomentum which is usually collapsed in the central region, in age or on exposure to rain, becoming smooth all over; color of margin whitish to light buff, changing toward the center to a deep reddish brown or gray brown, and often with a chocolate tint. The lighter color may extend far toward the center, or it may be confined to a distinct marginal zone. Flesh of two parts a very soft, spongy, superficial layer that is several mm. thick, and beneath this, next to the spines, a much firmer and deeper brown layer. The odor is penetrating and exactly like that of a pig-pen, resembling somewhat the drug fenugreek, but more disagreeable. It is faint when fresh, much stronger when dried. Taste slight, not acrid or sour.

Stem uneven, 1.5-4 cm. long, varying greatly in size, 0.5-2.3 cm. thick, usually larger and amorphous below, color of cap, the surface composed of a thick, spongy layer, the center of a hard, almost woody tissue that is deep wood brown to almost black.

Spines white their whole length when perfectly fresh, soon turning a light gray in older parts and, as drying proceeds, through a light clear salmon or directly to a light grayish salmon or grayish brown; they are crowded, very slender, and about 3-4 mm. long.

Spores (of No. 836) white, subspherical, echinulate, 3.3-4μ or a few oblong, up to 4.6μ long.

Common among leaves in deciduous woods. The species is easily distinguished from all others by the color, the strong odor and the absence of a peppery taste.

I am satisfied that our Chapel Hill plants are the same as the mountain ones named by Atkinson *H. putidum* (Mushrooms, etc., p. 199), and in this opinion Beardslee agrees. Banker, however, while thinking our plants either *H. amicus* or near, does not believe *H. putidum* to be the same. He says in a letter of January 7, 1915: "In the darker portions, combined with the tendency to become glabrate these approach *P. pullus* (Schaeff.), but in other respects they seem near *P. amicus* (Quel)." It is certain that this is the plant listed as *H. graveolens* by Curtis and it is very likely included in Fries' conception of that species.

318. Woods near Howell's Spring, September 28, 1911.
326. On ground in woods, Battle's Park, September 30, 1911.
797. Near Battle's Branch, September 16, 1913. Photo.
836. Near path in Battle's Park, directly east of Dr. Battle's house, September 25, 1913. Photo.
1276. On hillside near the branch just below Judge's spring, September 28, 1914. Two photos. Spores white, spherical, echinulate, 3.4-4.2μ.
1347. Battle's Park, north of cemetery, October 13, 1914.
1348. Woods east of Graded School, October 15, 1914.
1368. By path to Meeting of the Waters east from cemetery, October 14, 1914.
2378. Mixed pine and oak woods near Piney Prospect, July 8, 1916.
2405. Mixed woods near Meeting of the Waters, July 20, 1916. Photo.
3203. Among oak and other deciduous leaves. Hillside near Judge's Spring, October 10, 1918.

Asheville. Beardslee.
Common, base of stumps (as *H. graveolens*). Curtis.

2. **Phellodon alboniger** (Pk.) Banker

PLATE 26.

We have not found this in Chapel Hill and take the following from Beardslee's notes:

"Cap 2.5-7 cm. broad, nearly plane or slightly depressed at the center, pale, almost white, with a tomentum which covers the entire upper surface, in section showing two distinct layers, the outer pale, soft and usually water-soaked, the inner blue-black and hard.

"Teeth slender, white or gray, crowded, decurrent.

"Stem short, hard and black within, covered on the outside with a soft, spongy paler layer.

"This is not like any of our other species. The hard, black core and paler, spongy exterior are quite marked. I find it in oak woods."

Asheville. Beardslee.

3. **Phellodon tomentosus** (L.) Banker

This is reported by Schweinitz, but we have not found it, and its occurrence in this state must be considered doubtful. It is mostly northern in its distribution and except for the record by Schweinitz

PLATE 25

PHELLODON AMICUS. No. 1276

PLATE 26

PHELLODON ALBONIGER *Photo. by Beardslee*

has not been found south of New Jersey. It should be looked for in our mountains. The following is from Banker (Memoirs Torr. B. C. 12, No. 2:171. 1906):

"Plant terrestrial, mesopodous, gregarious, confluent, small, zonate; pileus plane to depressed, occasionally subinfundibuliform, nearly round, 1-2 cm. wide, often confluent into crust-like layers, sometimes several decimeters wide; surface radiately fibrous-striate, floccose-tomentose or subscrobiculate at the center of the disk, subsulcate-zonate, castaneous or darker near center to light cream-color or whitish at margin; margin thin, substerile; substance fibrous tough, thin; stem slender, terete, attenuate downward to a common floccose-tomentose base imbedded in the substratum, subpubescent, cream-colored above to glabrous dark reddish brown below, 1-1.5 cm. long, 2-7 mm. wide; teeth slender terete, acute, scarcely decurrent, whitish to cream-colored, 2 mm. long and less; spores subglobose, echinulate, white or hyaline, 3.5-4μ wide. Hab.: On ground among moss. August-November."

Middle district (Schw.) woods. Curtis.

4. **Phellodon Cokeri** Banker, n. sp.

PLATE 29.

The following description of this new species is by Dr. Howard J. Banker:

"Hymenophore terrestrial, mesopodous, gregarious, somewhat confluent, irregular and often deformed, light cinnamon brown to tawny, medium size to small; pileus obconic, depressed to subinfundibuliform, irregular, 1-6 cm. wide, 1-3 mm. thick; surface uneven, more or less scrobiculate, spongy to subpubescent, light cinnamon brown or sordid tawny, irregularly maculate, azonate; margin thin, acute, sterile; substance somewhat spongy above, harder and more compact within, very brittle when dry, concolorous with surface becoming darker toward center, azonate; stem central to eccentric, attenuate downward to an enlarged spongy base, more or less deformed, surface uneven, spongy to subpubescent, concolorous with cap, 1-3 cm. long, 3-10 mm. wide; teeth slender, terete, tapering, acute, subfleshy, ap-

pearing waxy when dried; but slightly decurrent, 'whitish when young becoming salmon' to reddish brown when dried, 3 mm. or less long becoming shorter toward margin and stem, 0.15-0.35 mm. wide, 10-12 to a sq. mm.; spores ovoid, hyaline, echinulate, 4-5 x 4.5-5.5μ wide; hyphae of trama colored yellowish brown, smooth, thin-walled, collapsing when dried, not recovering in KOH, scarcely separable in KOH, closely interwoven, branching, variable in width, 3.5-9μ wide, septate, segments very irregular, no clamp connections detected; odor strong of fenugreek.

"Type collected at Chapel Hill, N. C., on ground in woods, Battle's Park, September 19, 1908. W. C. Coker" (U. N. C. Herb. No. 47*a*).

5. **Phellodon Ellisianus** Banker

PLATE 29.

Plants small, gregarious, sometimes connate, in rather dry sandy soil in woods. Cap up to 1.5 cm. in diameter, usually 1-1.3 cm., depressed in center, the margin plane or curved; surface smooth except for the faint inherent radiations and a central area of spumy tissue which is lighter, faintly zonate, grayish-brown, about a blackish chestnut brown, and while wet irridescent with fine deep purple and green tints. Flesh tough and leathery, less than 0.5 mm. thick, with a distinct odor of fenugreek, much like that of *Phellodon amicus* but more agreeable.

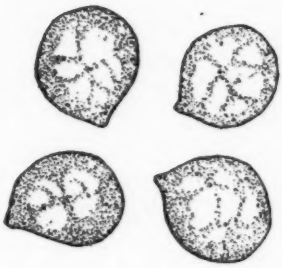
Spines very short and distant, slender, pointed, elongating from nothing near the sterile margin to about 0.6 mm. near the stem, slightly decurrent, covered all over with a fine, frosty puberulence which also covers the cap surface between them; a grayish salmon-brown color and lightest at the margin.

Stem central, tough, smooth, solid, about color of cap, turning almost black when wet after drying, about 5-6 mm. long and 1.5 mm. thick, slightly enlarged at the ground.

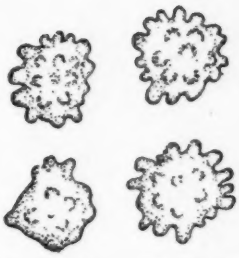
Spores hyaline, subspherical, minutely echinulate, 3.5μ in diameter.

This is a very distinct little species which was described by Banker from plants collected by Ellis in New Jersey. Our plants are the only

PLATE 27

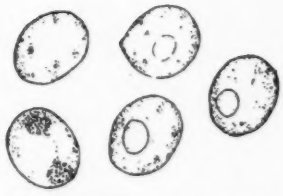


Hydnum repandum. No. 603

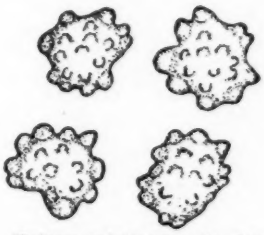


Hydnum Underwoodii. No. 1837

Hydnum albo-magnum. No. 1991

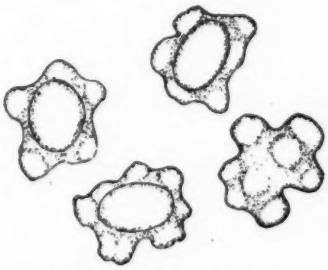


Manina cordiformis. No. 1277

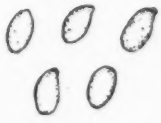


Hydnum imbricatum. No. 841

Manina flagellum. No. 1447



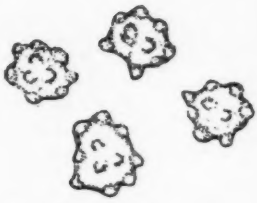
Hydnum scabripes. No. 1836



Steccherinum Rhois. No. 1511

PLATE 28

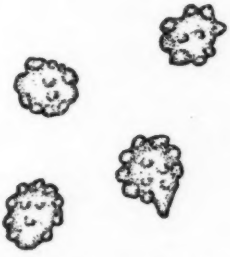
Steccherinum adustum. No. 1607



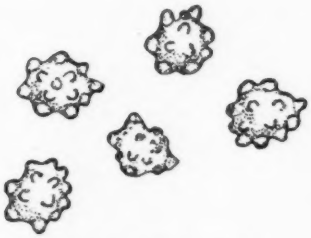
Hydnellum velutinum. Europe

Hydnellum diabolus. No. 1341

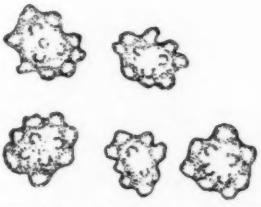
Hydnellum zonatum. No. 297a



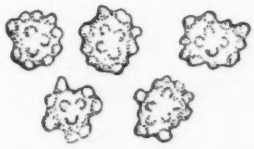
Hydnellum scrobiculatum. No. 292



Hydnellum zonatum. Italy

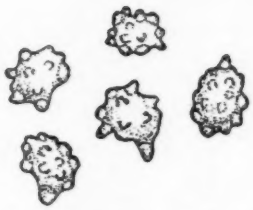


Hydnellum velutinum. No. 2412

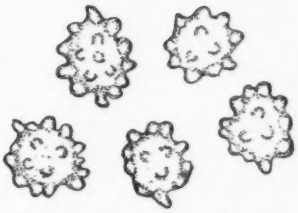


Hydnellum floriforme. No. 1241

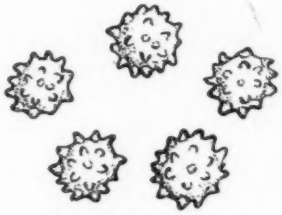
PLATE 29



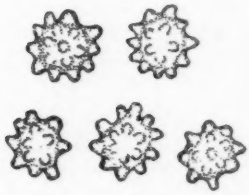
Hydnellum carolinianum. No. 1243



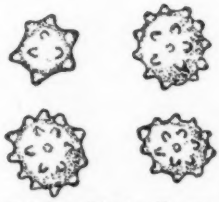
Hydnellum ferrugipes. No. 3201



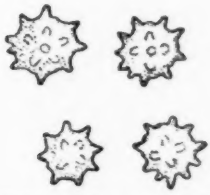
Phellodon amicus. No. 836



Hydnellum humidum. No. 1306



Phellodon Cokeri. No. 47a



Phellodon Ellisianus. No. 1325

ones that have been found since. They are like the type plants in the New York Botanical Garden except that the spines in the latter are closer and better developed than in ours.

1325. On rather dry sandy soil in woods southwest of cemetery, October 6, 1914. Drawing of spores.

GENUS HYDNOCHAETE.

Resupinate, very thin, fibrous, the teeth simple or branched, usually flattened towards the ends; growing on wood. This seems to be a connecting link between the *Hydnaceae* and the *Polyporaceae,* and Murrill places the genus in the latter family as *Hydnoporia.* As our plants show no signs of tubes even in the youngest stages, I think it less confusing to retain it in the Hydnaceae. We have but one species.

Hydnochaete olivaceum (Schw.) Banker

Irpex cinnamomeus Fr.

Hydnoporia fuscescens (in N. Am. Flora 9:3. 1907).

This is a peculiar plant, forming pendant, hydnoid teeth from an extensive, resupinate layer or from separate patches. The teeth are usually about 1 mm. long and branched once or twice, often flattened and appearing like the horns of a caribou; in extreme forms, as our No. 1973, the teeth may be much longer and more complexly branched, reaching 4 mm. in length. Resupinate portion and basal part of teeth tomentose. Entire plant a rusty cinnamon color. Texture tough and pliable when fresh, brittle when dry.

Setae (of No. 961) long, pointed, thick-walled, deep reddish brown, 8-12.5 x 50μ. Spores not found.

90. On dead beech limb in Battle's Park, October 18, 1911.
961. On dead beech limb by Durham road near bridge, October 29, 1913.
1973. On a fallen oak limb, Battle's Park, November 10, 1915.
3218. On a dead limb of tulip tree near Judge's Spring, October 9, 1918.

Asheville. Beardslee.
Common, trunks and limbs. Curtis.

A NEW SPECIES OF AMANITA.

By H. C. BEARDSLEE.

Amanita mutabilis n. sp.

PLATES 30 AND 31.

Cap 5-9 cm. broad, white or very pale cream color, not viscid, appearing smooth, but with flat closely appressed fragments of the volva which are slightly darker than the cap; slightly striate on the margin.

Stem 4-8 cm. long, 1-1.5 cm. thick, white, *solid*, fibrillose below the veil, abruptly enlarged below into a bulb 2-3 cm. thick, sheathed by the volva, which separates in a circumscissile manner with a distinct free margin.

Gills rather broad, white, mealy on the margin.

Veil thin, smooth, often breaking and forming fragments which remain attached to the margin of the cap.

Spores oblong ellipsoid, 6.5-7.5 x 11-14μ.

Odor not at all of chlorine, but rather pleasant and oily. Flesh of the stem changing to carmine (about Eugenia red of Ridgway) in three minutes.

Growing in white sand on Davis Island, N. C.

The characters of this species suggest a relationship to *A. pantherina* and *A. cothurnata*. It has the same curious sheathed bulb at the base of the stipe. In every specimen examined the volva had separated at the margin of the bulb in a definite line, and the margin had rolled back slightly, exactly as in *A. pantherina*. The cap if not carefully examined would be described as smooth. The remains of the volva are, however, left on the surface of the cap, and can be distinguished as slightly darker spots, and can be rolled up in rolls if the cap is gently rubbed. The quick change of color when the stem is wounded is different from anything I have observed in Amanita. The change

PLATE 30

AMANITA MUTABILIS

Photo. by Beardslee

PLATE 31

AMANITA MUTABILIS

Photo. by Mrs. Ravenel

is much quicker and much more distinct than in *A. rubescens.* Three minutes seemed to be the usual period for developing a deep carmine. It seems amply distinct from the other sheathed Amanitas in character and its spores.*

ASHEVILLE, N. C.

*NOTE BY THE EDITOR.—Soon after Mr. Beardslee found the Davis Island plants a photograph was sent me by Mrs. I. M. Jervey of Charleston, and later a collection of dried plants of this species. The quick change to bright red was noted by Mrs. Jervey for her plants also, and I find the spores nearly the same (7.4-8 x 11-13μ). I publish herewith the photo by Mrs. Jervey, which shows a good veil.—W. C. C.